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REPORT

ON

TALLY LAKE

FLATHEAD COUNTY

MONTANA

EPA REGION VIII

WORKING PAPER NO. 801

WITH THE COOPERATION OF THE

MONTANA DEPARTMENT OF HEALTH & ENVIRONMENTAL SCIENCES

AND THE

MONTANA NATIONAL GUARD

MAY, 1977

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U.S. Environmental Protection Agency) express sincere appreciation to the Montana Department of Health and Environmental Sciences for professional involvement, to the Montana National Guard for conducting the tributary sampling phase of the Survey, and to those Montana wastewater treatment plant operators who voluntarily provided effluent samples.

The staff of the Water Quality Bureau provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

Major General John J. Womack, the Adjutant General of Montana, and Project Officer Major William Yeager, who directed the volunteer efforts of the Montana National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY
STUDY LAKES AND RESERVOIRS
STATE OF MONTANA

LAKE NAME	COUNTY
Canyon Ferry	Broadwater, Lewis and Clark
Clark Canyon	Beaverhead
Flathead	Flathead, Lake
Georgetown	Deer Lodge, Granite
Hebgen	Gallatin
[illegible]	Lincoln, MT; British Columbia, Can.
Mary Ronan	Lake
McDonald	Flathead
Nelson	Phillips
Seeley	Missoula
Swan	Lake
Tally	Flathead
Tiber	Liberty, Toole
Tongue River	Big Horn
Whitefish	Flathead
Yellowtail	Carbon, Bighorn, MT; Bighorn, WY

TALLY LAKE
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
Scale
TALLY LAKE

TALLY LAKE

STORET NO. 3017

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Tally Lake is oligo-mesotrophic. It ranked fourth in overall trophic quality when the 15 Montana lakes and reservoirs sampled in 1975 were compared using a combination of six parameters*. Four of the water bodies had less median total phosphorus, five had less and three had the same median inorganic nitrogen, two had less and three had the same median orthophosphorus, three had less mean chlorophyll a, and five had greater mean Secchi disc transparency. No significant depression of dissolved oxygen occurred at depths as great as 52 meters.

Survey limnologists did not observe any nuisance conditions and commented on the attractive appearance of the lake.

B. Rate-Limiting Nutrient:

Due to significant nutrient changes in the algal assay samples, the assay results are not considered representative of conditions in the lake at the times of sampling.

The lake data indicate nitrogen limitation in June and phosphorus limitation in July and September.

C. Nutrient Controllability:

1. Point sources--No known municipal or industrial point

* See Appendix A.

sources impacted Tally Lake during the sampling year. Septic tanks serving a lakeshore dwelling and a campground were estimated to have contributed 0.2% of the total phosphorus load, but a shoreline survey would be necessary to determine the actual significance of those sources.

The present phosphorus loading of 0.51 g/m^2/year is slightly more than that proposed by Vollenweider (Vollenweider and Dillon, 1974) as an oligotrophic loading, and every effort should be made to keep phosphorus inputs at the lowest practicable level to protect the existing trophic quality of Tally Lake.

2. Non-point sources--Non-point sources, including precipitation, accounted for 99.8% of the total phosphorus load to Tally Lake during the sampling year. Logan Creek contributed 80.9% of the total load, and the ungaged tributaries added an estimated 15.5% of the total.

The non-point phosphorus export rate of Logan Creek was 5 kg/km^2/yr. This rate is quite low as compared to the rates of two unimpacted tributaries of nearby Whitefish Lake* (9 and 21 kg/km^2/yr).

* Working Paper No. 804.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††;

1. Surface area: 5.37 kilometers²,

2. Mean depth: 68.9 meters,

3. Maximum depth: 150.0 meters,

4. Volume: 369.993 x 10^6 m^3,

5. Mean hydraulic retention time: 2.8 years,

B. Tributary and Outlet;
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Logan Creek	437.2	3.620
Minor tributaries & immediate drainage -	84.5	0.630
Totals	521.7	4.250**

2. Outlet -

Logan Creek	527.1***	4.250

C. Precipitation****;

1. Year of sampling: 73.6 centimeters,

2. Mean annual: 75.3 centimeters,

† Table of metric conversions--Appendix B.
†† Dumrose, 1975.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Sum of inflows adjusted to equal outflow.
*** Includes area of lake.
**** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Tally Lake was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at two stations on the lake (see map, page v). During each visit, a single depth-integrated (4.6 m to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first and last visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depth sampled at both stations was 51.8 meters.

The sampling results are presented in full in Appendix D and are summarized in the following table.

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
06/02/75	1. Dinobryon sp.	322
	2. Synedra sp.	290
	3. Flagellates	250
	4. Asterionella sp.	226
	5. Stephanodiscus sp.	193
	Other genera	129
	Total	1,418
07/28/75	1. Chroomonas sp.	106
	2. Oscillatoria sp.	35
	Total	141
09/05/75	1. Fragilaria sp.	1,107
	2. Dinobryon sp.	420
	3. Chroomonas sp.	191
	4. Centric diatoms	153
	5. Cryptomonas sp.	38
	Other genera	38
	Total	1,947

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (ug/l)
06/02/75	1	2.7
	2	2.5
07/28/75	1	1.7
	2	2.2
09/05/75	1	1.2
	2	2.2

C. Limiting Nutrient Study:

Due to significant nutrient changes in the algal assay samples during shipment from the field to the laboratory, the results are not considered representative of lake conditions at the times of sampling (06/02/75 and 09/05/75).

The lake data indicate Tally Lake was nitrogen limited in June and phosphorus limited in July and September. At those times, the mean inorganic nitrogen to orthophosphorus ratios were 5 to 1, 16 to 1, and 19 to 1, respectively.

IV. NUTRIENT LOADINGS
(See Appendix F for data)

For the determination of nutrient loadings, the Montana National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of May and June when two samples were collected. Sampling was begun in October, 1974, and was completed in September, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Montana District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the nutrient loads, in $kg/km^2/year$, at station A-2 and multiplying by the ZZ area in km^2.

No known wastewater treatment plants impacted Tally Lake during the sampling year.

A. Waste Sources:

1. Known municipal - None*
2. Known industrial - None

* See Working Paper No. 175.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Logan Creek	2,210	80.9
b. Minor tributaries & immediate drainage (non-point load) -	425	15.5
c. Known municipal STP's - None	-	-
d. Septic tanks* -	5	0.2
e. Known industrial - None	-	-
f. Direct precipitation** -	95	3.4
Total	2,730	100.0

2. Outputs -

Lake outlet - Logan Creek 2,035

3. Net annual P accumulation - 695 kg.

* Estimate based on 1 campground and 1 dwelling; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Logan Creek	149,750	81.1
b. Minor tributaries & immediate drainage (non-point load) -	28,985	15.7
c. Known municipal STP's - None	-	-
d. Septic tanks* -	80	<0.1
e. Known industrial - None	-	-
f. Direct precipitation** -	5,795	3.2
Total	184,610	100.0

2. Outputs -

Lake outlet - Logan Creek	170,390

3. Net annual N accumulation - 14,220 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Logan Creek	5	343

* Estimate based on 1 campground and 1 dwelling; see Working Paper No. 175.
** See Working Paper No. 175.

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	0.51	0.13	34.4	2.6

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Tally Lake:

"Dangerous" (eutrophic loading)	0.96
"Permissible" (oligotrophic loading)	0.48

V. LITERATURE REVIEWED

Domrose, Bob, 1975. Personal communication (lake morphometry). MT Dept. of Fish & Game, Kalispell.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] INORG N	SUR- MEAN SEC	[illegible] CHLPHA	TP- [illegible] 25	[illegible] BOSS [illegible] P
3001	CANYON FERRY RESERVOIR	0.347	0.178	442.681	5.039	14.408	0.027
3002	CLARK CANYON RESERVOIR	0.344	0.248	346.752	2.375	12.888	0.027
3003	FLATHEAD LAKE	0.384	0.251	267.833	1.273	9.898	0.004
3004	GEORGETOWN RESERVOIR	0.422	0.248	367.333	6.963	18.288	0.041
3005	HEBGEN RESERVOIR	0.422	0.248	367.708	4.883	13.888	0.028
3006	KOOCANUSA RESERVOIR	0.345	0.188	337.643	2.889	10.488	0.024
3007	MARY RONAN LAKE	0.828	0.248	371.841	4.673	14.238	0.008
3008	MC DONALD LAKE	0.884	0.198	198.447	8.467	9.488	0.002
3009	NELSON RESERVOIR	0.429	0.275	458.758	7.233	23.438	0.007
3010	SEELEY LAKE	0.415	0.248	362.657	2.171	13.208	0.018
3011	SWAN LAKE	0.318	0.258	282.758	3.296	9.048	0.014
3012	TALLY LAKE	0.811	0.258	334.167	2.892	9.288	0.014
3013	TIBER RESERVOIR	0.914	0.148	442.555	2.826	9.488	0.004
3014	TOSTON RIVER RESERVOIR	0.851	0.258	474.111	26.478	13.488	0.028
3015	WHITEFISH LAKE (LOWER)	0.885	0.242	298.288	1.488	7.488	0.013

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	RELATIVE TOTAL P	RELATIVE INORG N	SUS- MEAN SED	MEAN CHLPHA	15- MIN DO	RELATIVE SECCHI P	INVERT RA
3011	CANYON FERRY RESERVOIR	14 (21)	14 (21)	21 (31)	21 (31)	8 (81)	7 (11)	77
3012	CLARK CANYON RESERVOIR	7 (11)	21 (31)	29 (44)	64 (96)	36 (54)	14 (21)	171
3013	FLATHEAD LAKE	89 (132)	61 (89)	93 (139)	93 (139)	86 (128)	75 (96)	447
3014	HIGGINS RESERVOIR	34 (51)	79 (103)	50 (71)	14 (21)	57 (85)	29 (44)	248
3015	HOGEN RESERVOIR	39 (59)	79 (103)	43 (64)	36 (54)	14 (21)	21 (32)	232
3016	HOUCHASSA RESERVOIR	21 (31)	29 (44)	71 (103)	57 (85)	50 (75)	1 (81)	228
3017	MARY ADAIR LAKE	93 (71)	96 (139)	36 (54)	29 (44)	7 (11)	57 (85)	275
3018	MC DONALD LAKE	100 (144)	4 (81)	100 (144)	100 (144)	100 (144)	100 (144)	534
3019	NELSON RESERVOIR	29 (44)	36 (54)	7 (11)	7 (11)	47 (69)	58 (75)	172
3020	SEELEY LAKE	64 (96)	96 (139)	57 (85)	71 (103)	29 (44)	36 (54)	353
3021	SWAN LAKE	79 (117)	46 (69)	68 (100)	43 (69)	64 (96)	75 (96)	247
3022	TALLY LAKE	71 (103)	61 (89)	64 (96)	79 (111)	79 (111)	75 (96)	429
3023	TIBER RESERVOIR	57 (85)	4 (81)	14 (21)	50 (71)	68 (96)	75 (96)	216
3024	TUNGE RIVER RESERVOIR	0 (81)	46 (69)	0 (81)	0 (81)	21 (31)	43 (69)	116
3025	WHITEFISH LAKE (LOWER)	86 (125)	79 (103)	79 (111)	86 (125)	93 (139)	93 (139)	515

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	3019	WHITEFISH LAKE (LOWER)	519
2	3006	MC DONALD LAKE	504
3	3003	FLATHEAD LAKE	447
4	3012	TALLY LAKE	429
5	3011	SWAN LAKE	347
6	3016	SEELEY LAKE	353
7	3007	MARY RONAN LAKE	275
8	3013	TIGER RESERVOIR	268
9	3004	BOTHELTON RESERVOIR	268
10	3005	CHIEN RESERVOIR	232
11	3006	KOOCANUSA RESERVOIR	229
12	3014	NELSON RESERVOIR	172
13	3042	CLARK CANYON RESERVOIR	171
14	3034	TONGUE RIVER RESERVOIR	138
15	3041	CANYON FERRY RESERVOIR	77

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

APPENDIX D

PHYSICAL and CHEMICAL DATA

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	24	17	[illegible]	[illegible]		
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	13	42	[illegible]	[illegible]		
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APPENDIX E

TRIBUTARY DATA

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